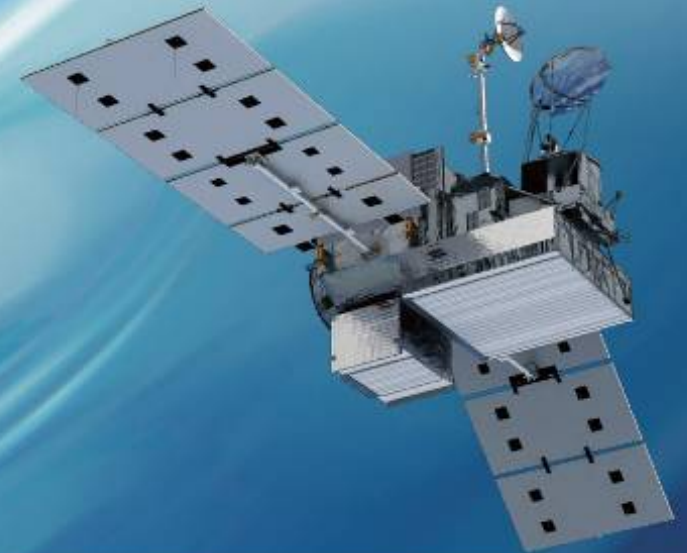




# **JAXA TRMM/GPM Program Status (including DPR sensor status)**

**Riko OKI (JAXA/EORC)**



# Japanese PMM Science Team

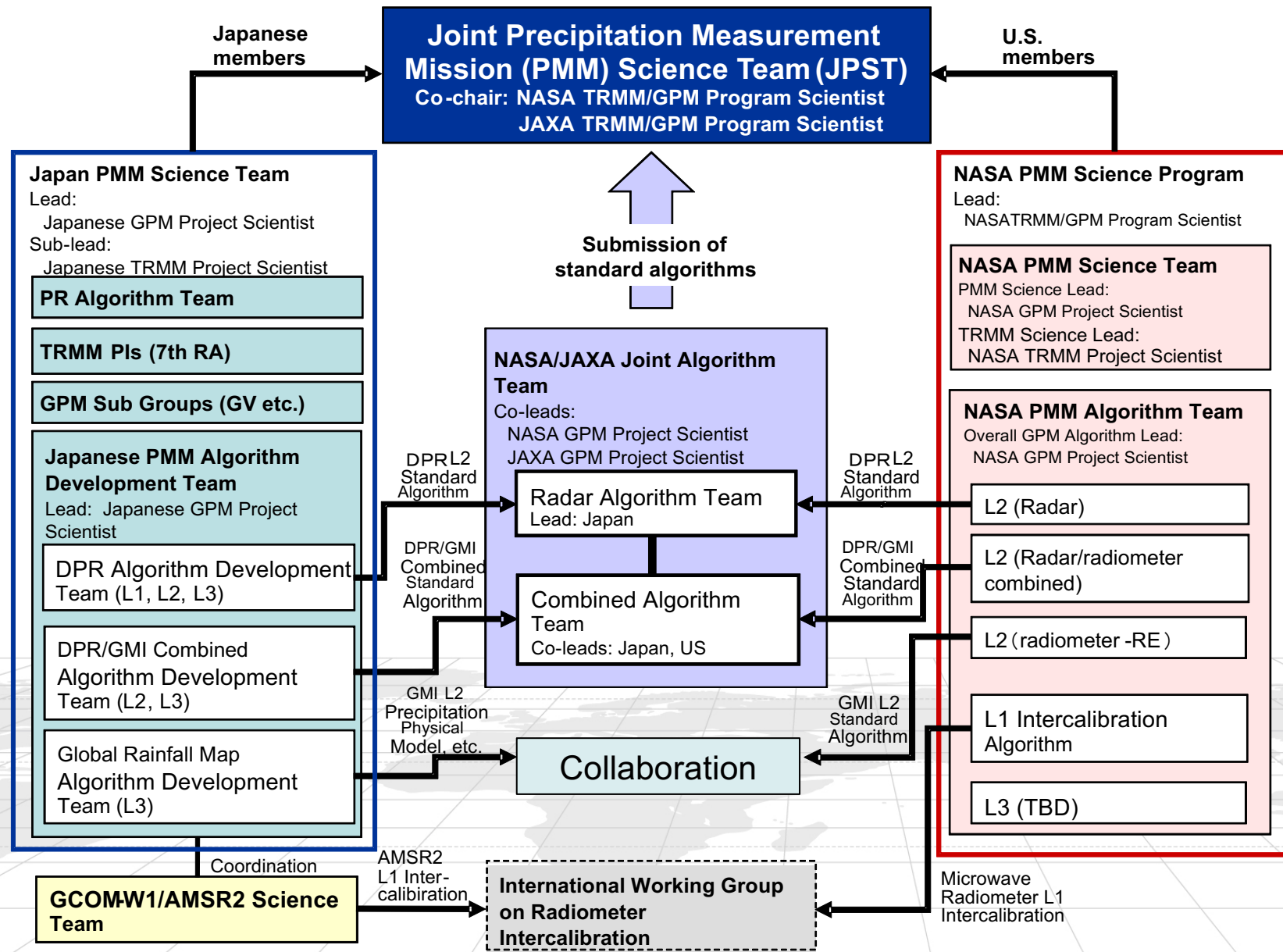


- \* The current Japanese PMM Science Team started in Apr. 2016 for three-year period.
  - \* 41 proposals for the 8<sup>th</sup> RA (JFY2016-2018)
    - \* It is the 8<sup>th</sup> RA since the first TRMM RA, and the 4<sup>th</sup> as PMM
    - \* 30 with research cost proposals
    - \* 13 no cost transfer proposals including 10 from abroad
  - \* The science team includes both TRMM and GPM activities.
- \* The next RA will be announced in JFY2018 for the three-year period JFY2019-2021.

# Japan and U.S. PMM Science Framework

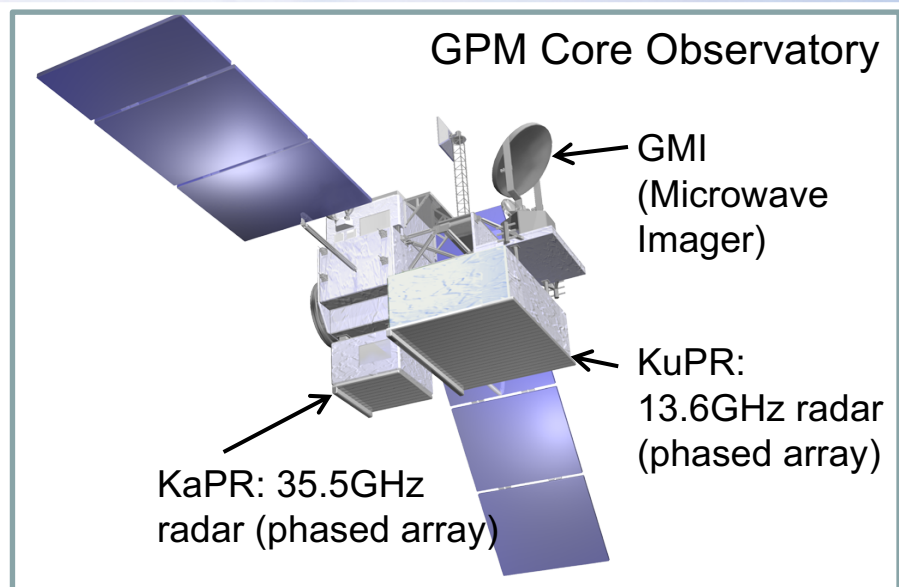


-- two joint algorithm development teams --





# Global Precipitation Measurement (GPM)



- GPM is an international mission consisting of the GPM Core Observatory and Constellation Satellites for high accurate and frequent global precipitation observation.

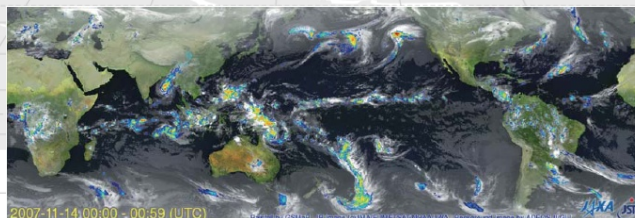
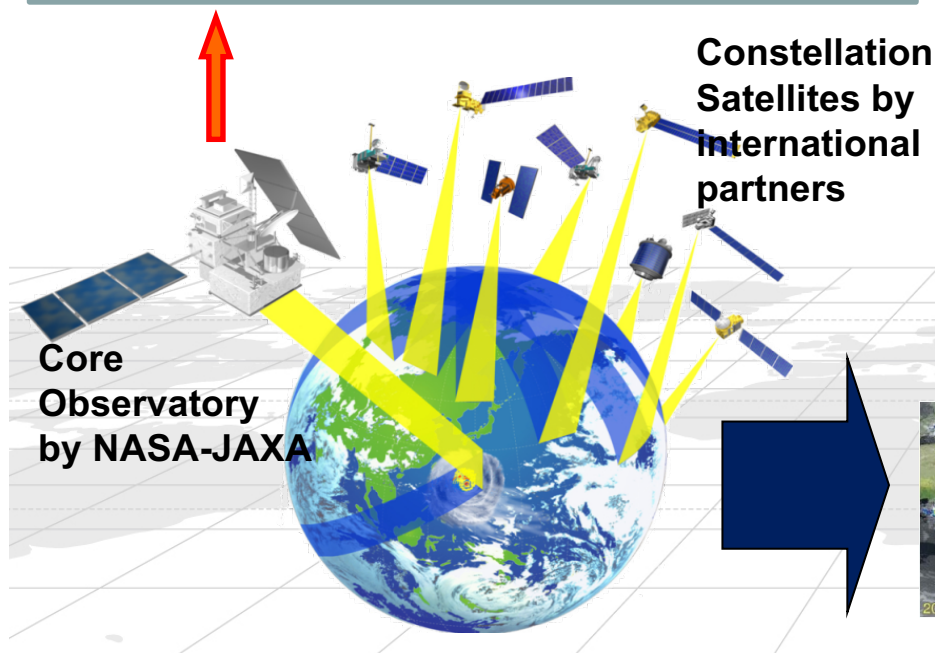
- Core Observatory: developed under NASA and JAXA equal partnership.
- Constellation satellites: provided by international partners (includes GCOM-W1).

## ■ Dual-frequency Precipitation Radar (DPR)

- developed by JAXA and NICT
- DPR is composed of two radars: KuPR & KaPR

- GPM Core Observatory was successfully launched **on 28 Feb. 2014 (JST)**.

- All GPM standard products were released on September 2014.





# JAXA GPM mission status



- \* After the launch on February 2014, 3-year and 2-month operation was completed at the end of April 2017.
- \* JAXA completed the End of Prime mission review of the GPM/DPR on June 19<sup>th</sup> 2017 to confirm achievements of the mission requirement.
- \* The GPM/DPR management review will be held on 26<sup>th</sup> October 2017 for approval to move extended mission phase.
- \* We'll hold a symposium for the public of the GPM on 30<sup>th</sup> Nov. 2017 at Tokyo.

# DPR Sensor Status

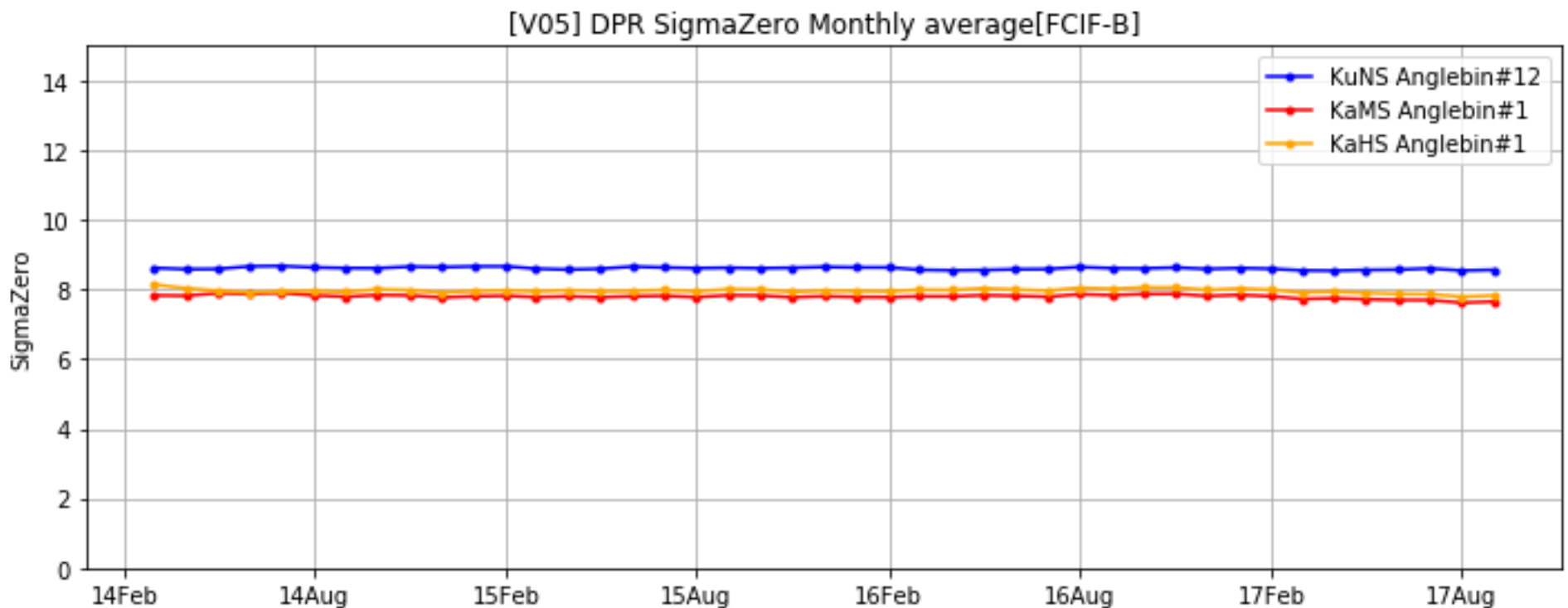
- \* JAXA is continuing DPR data monitoring to confirm that DPR function and performance are kept on orbit.
  - \* Operation Mode
  - \* Temperature
  - \* Bus Voltage and Current
  - \* System Noise
  - \* Sea Surface Radar Cross Section ( $\sigma_0$ )
  - \* Internal Calibration
    - \* ~1 time / week
  - \* External Calibration
    - \* 2 periods / year (~5 times / period)
  - \* TX/RX Amplifier Status
    - \* 2 times / year

DPR data monitoring results show that there is no degradation of DPR function and performance from Launch till now.



# Trends of DPR $\sigma^0$ statistics

- \* Trends of DPR  $\sigma^0$  statistics have been stable.
- \* DPR has observed normally without any problems in both transmitter and receiver system.



NOTE:

- These statistics values are monthly average over ocean.



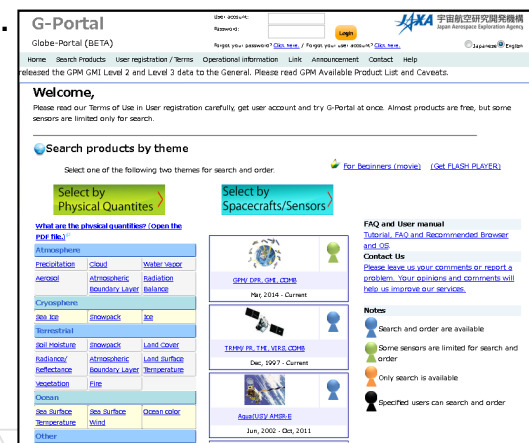
# GPM/DPR Ground System Status



- \* JAXA Mission operations System (MOS) operation is normal, but needs server replacement.
- \* Data reception/dissemination system was replaced in September 2017.
- \* Data processing system will be replaced in JFY2018.
- \* JAXA's super computer has been used for reprocessing.
- \* 17yr PR L1 processing was completed within 44 hours.

- \* GPM/TRMM V7 data is available from G-Portal.

- \* <https://www.gportal.jaxa.jp/gp/top.html>
- \* Data Search & Download (https)
- \* Direct Get (sftp)



- \* TRMM V8 data is also available from new G-Portal FTP server.

- \* <ftp.gportal.jaxa.jp>
- \* Please generate new account at <https://gportal.jaxa.jp/gpr/> in advance, and login with your ID and “anonymous” password for FTP direct get.

*We recommend that Japanese/Asian users get TRMM/V8 huge amount data from G-Portal.*

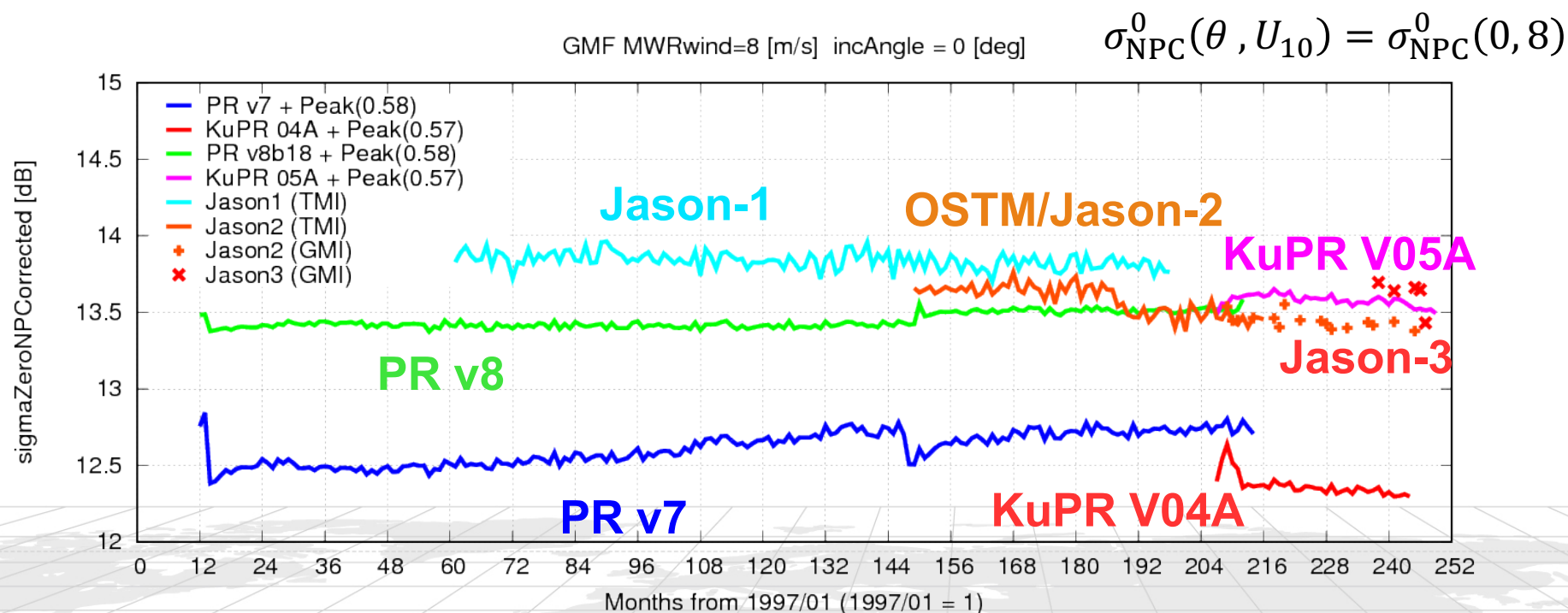
# GPM Algorithm Development Status (Summary)

- \* DPR Level 1 algorithm (JAXA)
  - \* V05 product was released in May 2017.
- \* DPR Level 2 and 3 algorithm (Joint Japan-U.S.)
  - \* V05 product was released in May 2017.
- \* DPR/GMI combined Level 2 algorithm (Joint Japan-U.S.)
  - \* V05 product was released in May 2017.
- \* DPR Latent heating algorithm (Japan-U.S.)
  - \* DPR Spectral Latent Heating (SLH) V05 product was released in July 2017.
- \* Global Rainfall Map algorithm [GSMaP] (Japan)
  - \* V04 Product was released in January 2017.
- \* TRMM/PR Level 1 algorithm (JAXA)
  - \* V8 product was released in October 2017.
- \* TRMM/PR Level 2 and 3 algorithm (Joint Japan-U.S.)
  - \* V8 product will be released in 2018.

# Performances of DPR L1 V05 & PR L1 V8

\* Comparisons of the NRCS ( $\sigma^0$ ) with various sensors.

→ Better continuity of the TRMM/PR V8 and the GPM/KuPR V05



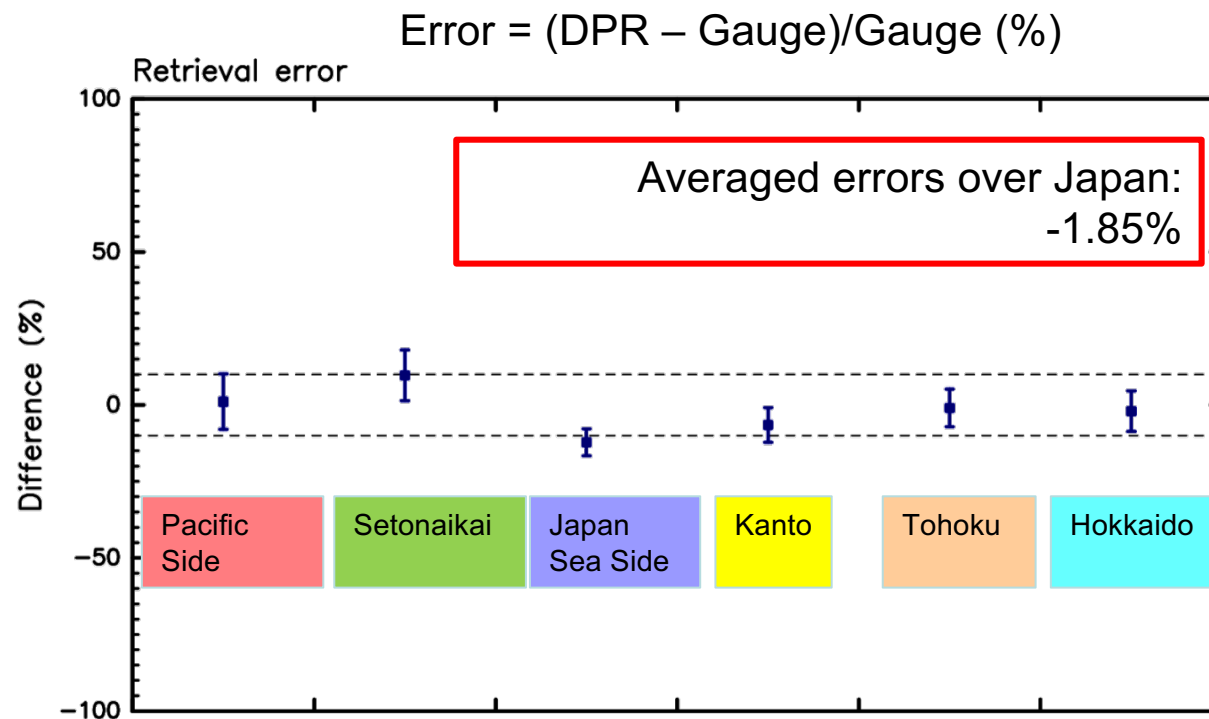
TRMM PR : 13.8 GHz  
GPMCore KuPR : 13.6 GHz  
Jason Poseidon : 13.6 GHz

(\*1)  $\sigma^0$  of PR v8b18 is almost the same with the latest PR V8.

Sampling biases of PR and KuPR caused by the their range sampling (~125m) are corrected in the figure.

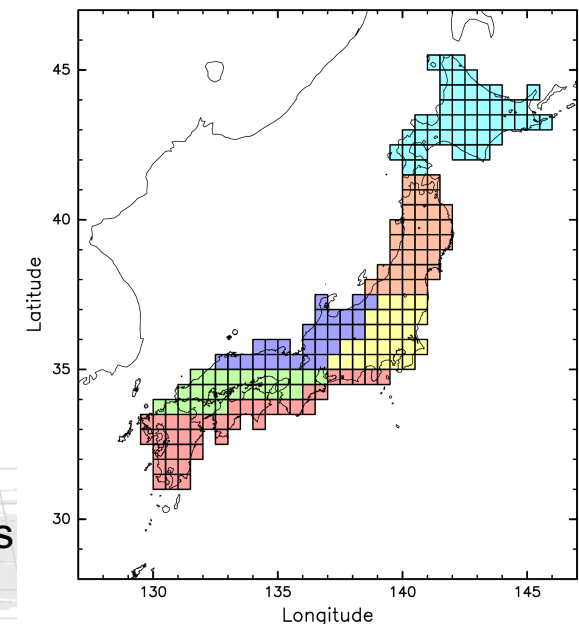


# Comparisons of DPR rain estimates with JMA AMeDAS rain gauge data



6 areas

1. Hokkaido (No. of boxes: 45)
2. Tohoku (34)
3. Kanto (27)
4. Sea of Japan side (27)
5. Inland Sea area (27)
6. Pacific Ocean side (39)

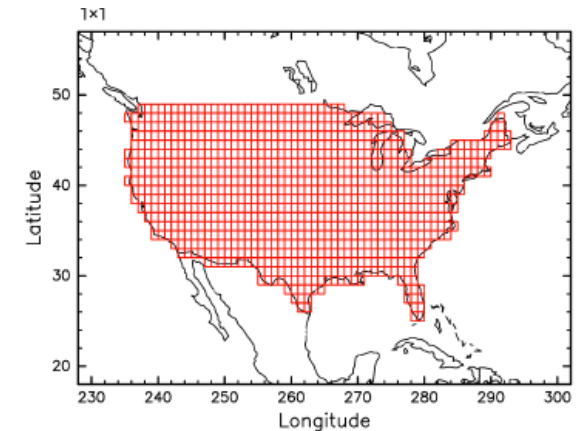


- Two years of data from June 2014 to May 2016
- AMeDAS data at overpasses only
- Gauge data are 10 min data immediately after the overpasses
- Rain total is estimated at each  $0.5 \times 0.5$  deg. box, and means and standard deviations of 6 colored areas are calculated.
- To exclude snow fall data, if the surface temperature is below 6 degrees, data in that box are not used.

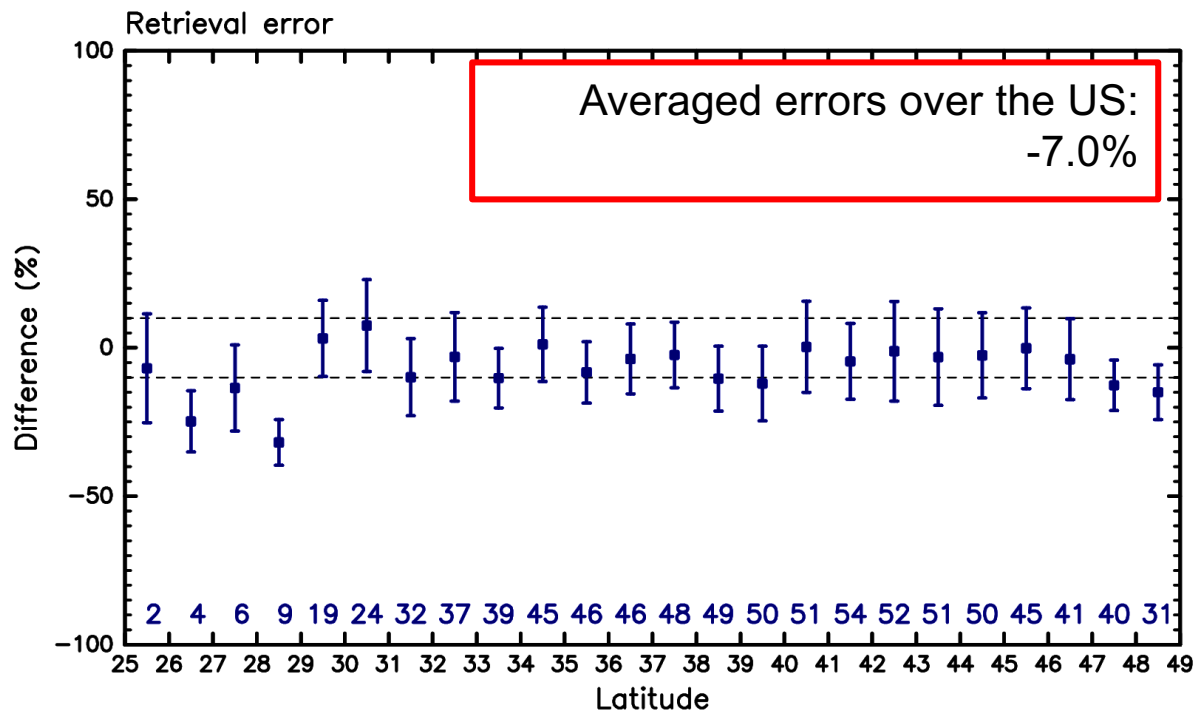
# DPR(MS) (V05) and US MRMS



- US Multi-Radar Multi-Sensor (MRMS) DatasetMRMS (provided by NASA GV team)
- June 2014 – Mar. 2016 without winter season (Dec. Jan. Feb)
  - DPR overpass time only



DPR - MRMS  
MRMS



$$\text{Error} = (\text{DPR} - \text{MRMS}) / \text{MRMS} (\%)$$

-7.0  
22/24

# GPM/DPR Data Assimilation in the JMA NWP system

The Japan Meteorological Agency (JMA) started the DPR assimilation in the meso-NWP system on March 24 2016.

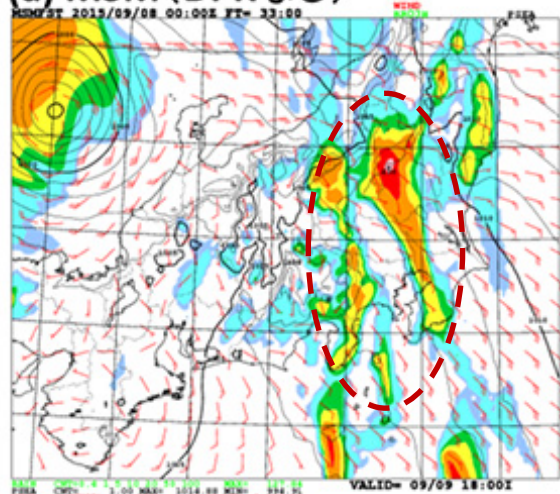
World's first "operational" assimilation of spaceborne radar data in the NWP system of meteorological agencies!

a) 33-hour prediction without the DPR

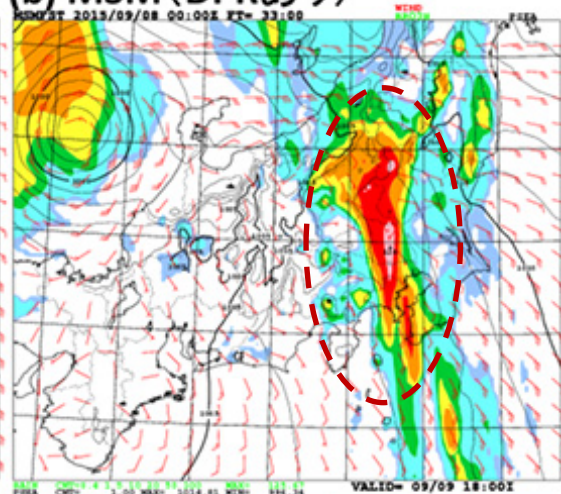
b) 33-hour prediction with the DPR

c) Observation

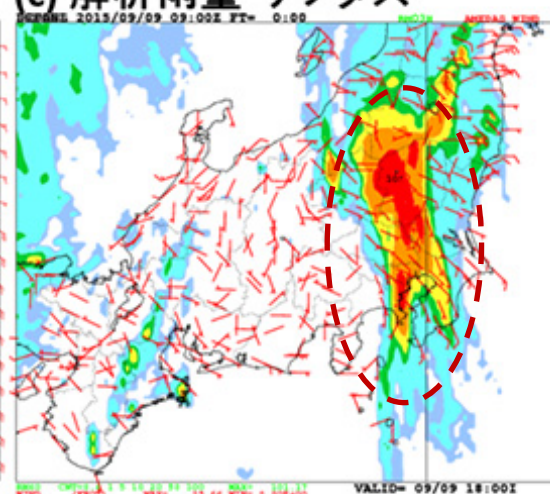
(a) MSM (DPRなし)



(b) MSM (DPRあり)



(c) 解析雨量・アメダス



.4 1 5 10 20 50 100 (mm/3h)

- Example of Kanto-Tohoku Heavy Rainfall in 2015
- Improvements in water vapor analysis accuracy over the ocean
- Improvements in rainfall forecast accuracy

Provided by JMA

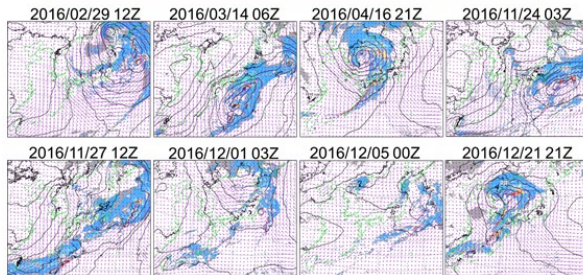


# DPR SLH V05 product

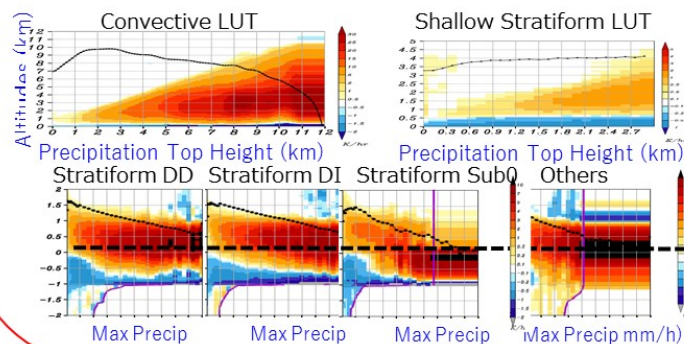
- \* GPM latent heating V05 product released in Jul. (SLH) and Aug. (CSH) 2017 included LH retrievals over mid-latitudes.

## Retrieval of Mid-latitude LH Using GPM DPR

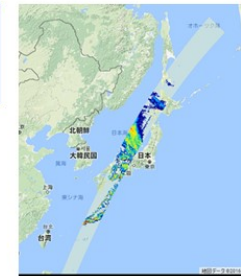
8 Extratropical Cyclone cases  
Simulated with JMA LFM



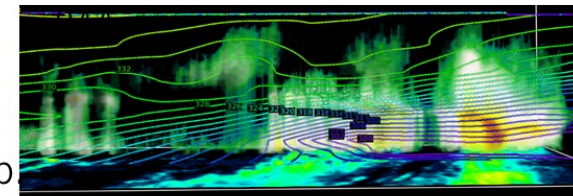
LH Look Up Tables : Precip → LH



Extratropical Cyclone Captured  
with GPM DPR



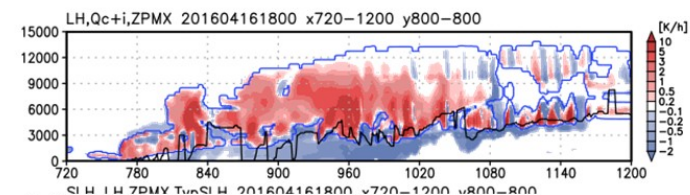
Radar Reflectivity 2ADPR\_NS



Input GPM  
KuPR-precip

output

LH, Q1-QR, Q2



(provided by Prof. Takayabu, Univ. Tokyo)

# Scan pattern experiments in Sep. 2017



- \* Two scan pattern experiments and transmitters OFF operation were scheduled.

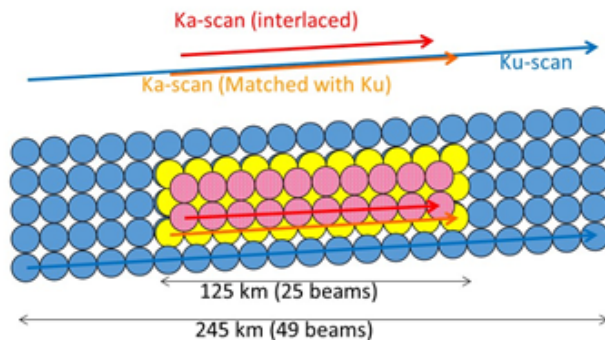
Experiments	Date
Wide swath experiment	Sep 26 13UTC - Sep 27 13UTC
KaPR's scan pattern experiment	Sep 27 13UTC - Sep 28 13UTC
Transmitters OFF operations	Sep 28 13UTC - Sep 29 13UTC

- \* All experiments were completed.
- \* These data will help feasibility studies of possible KaPR scan pattern change in extended mission period and the future spaceborne radar development.

# KaPR's scan pattern experiment (KaPR only)

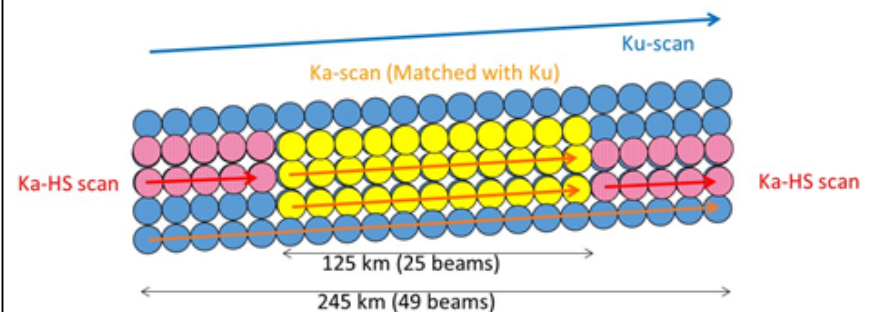
## Possible Scan Patterns (current)

- Ku footprint (245 km swath with 49 beams)
- Ka footprint (125 km swath, matched with Ku, 250 m range res.)
- Ka footprint (Interlaced, 500 m range res., high sensitivity)



## Possible KaPR Scan Pattern I

- Ku footprint (245 km swath with 49 beams)
- Ka footprint (matched with Ku in inner swath, 250 m range res., low sensitivity)
- Ka HS footprint (matched with Ku in outer swath, 500 m range res., high sensitivity)



## (1) Major changes:

- KaPR-HS's scan pattern was changed.  
→ Dual-frequency technique will be applied in a full swath.

## (2) Minor changes:

- Scan timing of KaPR-MS scan was slightly changed to realize improvement of beam matching between KuPR and KaPR (by a request from the DPR-L2 team).

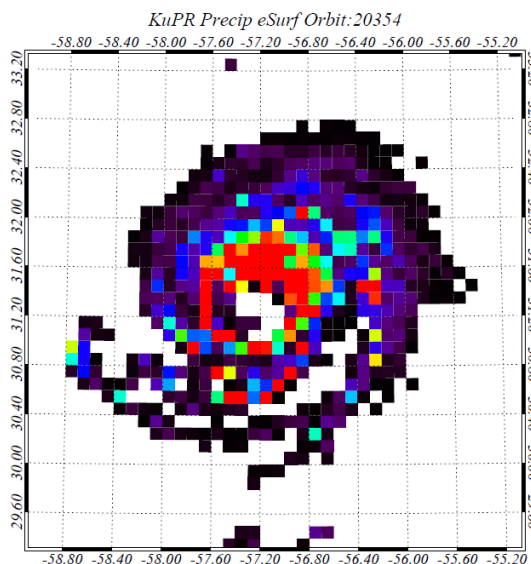


# Preliminary KaPR's scan pattern experiment

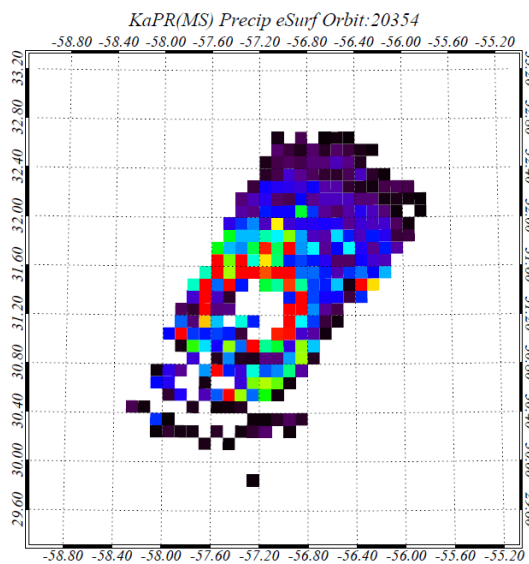
Sep 27<sup>th</sup> 2017 Hurricane LEE

Precipitation (eSurf)

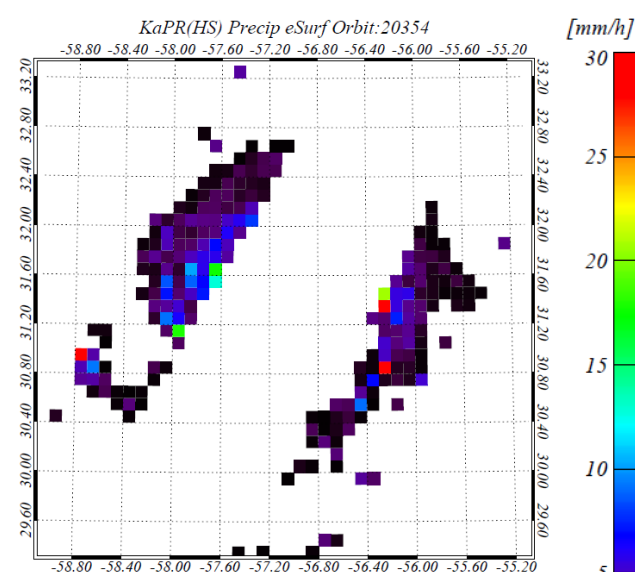
**KuPR**



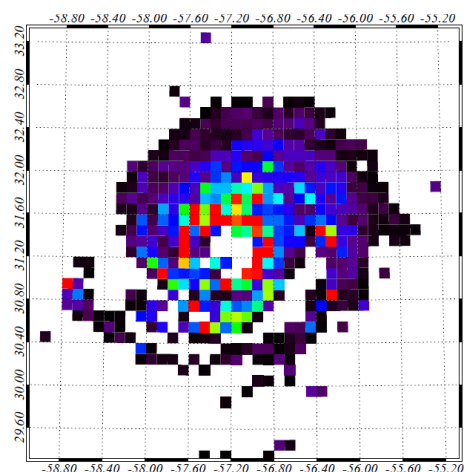
**KaPR(MS)**



**KaPR(HS)**



**KaPR(MS/HS)**



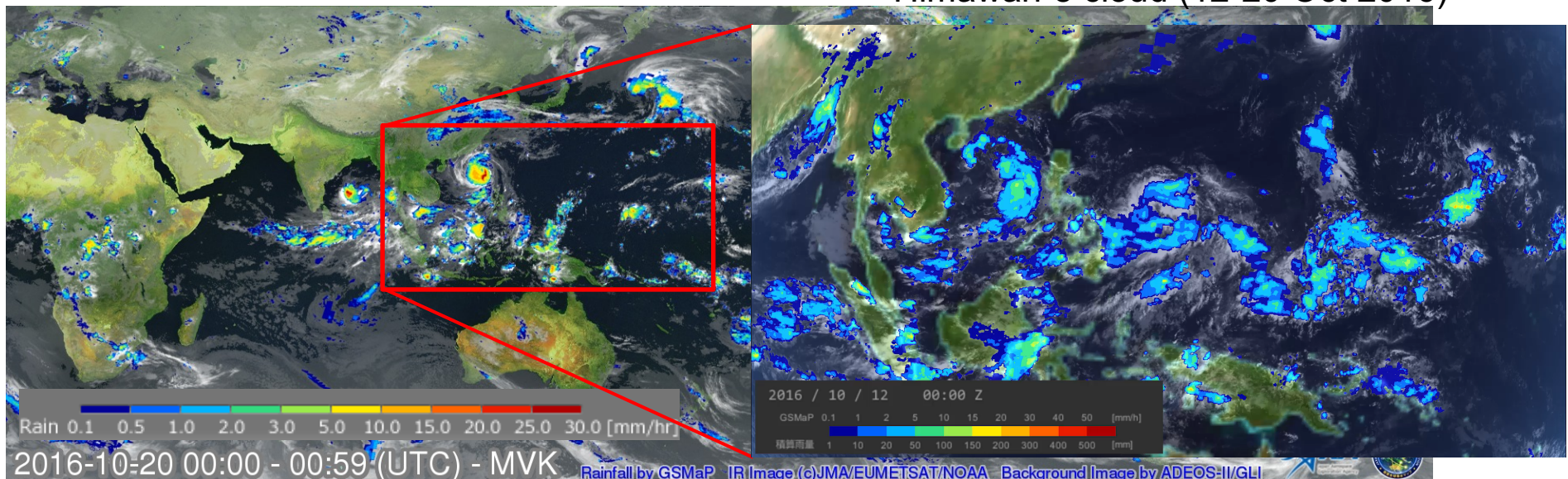
Dual-frequency technique  
will be applied in a full swath.

# Global Satellite Mapping of Precipitation (GSMaP)



<http://sharaku.eorc.jaxa.jp/GSMaP/>

GSMaP\_NRT hourly rain with  
Himawari-8 cloud (12-20 Oct 2016)



\* GSMaP is a blended Microwave-IR product and has been developed in Japan toward the GPM mission.

\* U.S. counterpart is “IMERG”

\* GSMaP (v6) data was reprocessed as reanalysis version (**GSMaP\_RNL**) since Mar. 2000 period , and was open to the public in Apr. 2016, and new version, GSMaP (v7) was released in 17 Jan. 2017.

\* GSMaP realtime product (**GSMaP\_NOW**) in the domain of GEO-Himawari, GSMaP Riken Nowcast (**GSMaP\_RNC**) data developed by RIKEN/AICS (Otsuka et al. 2016) are now available from JAXA/EORC ftp site.



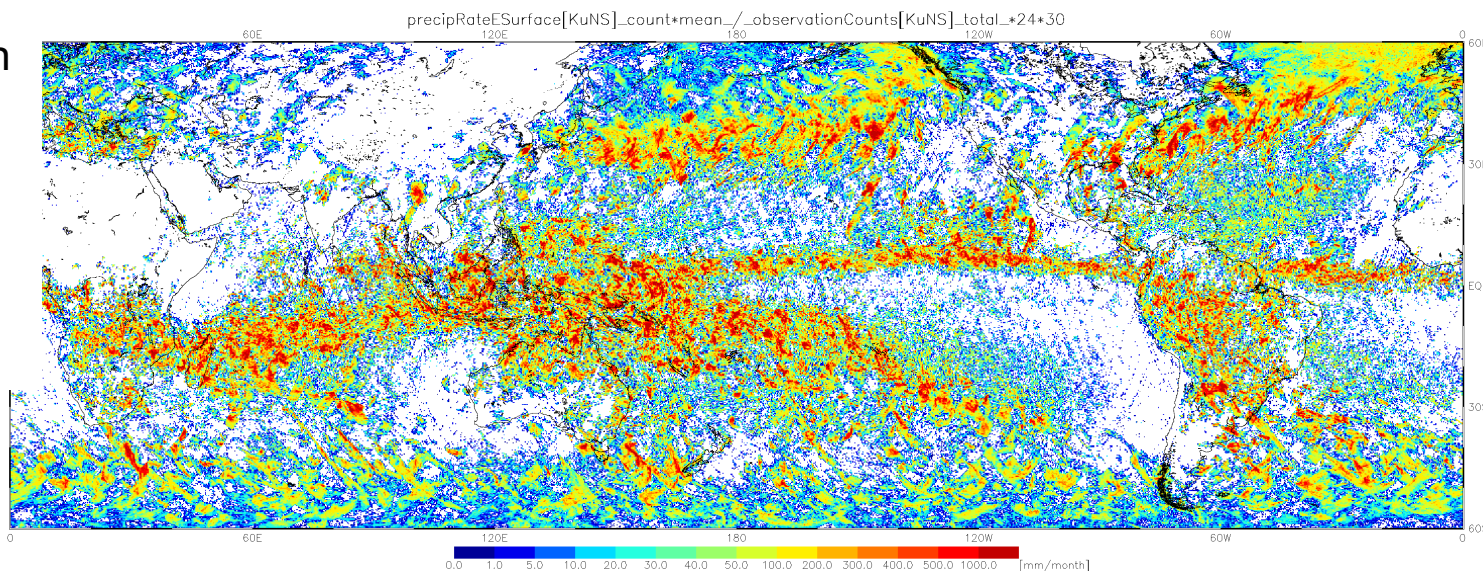
# Changes in the GSMaP new version released in January 2017



Surface precipitation amount of the GPM/KuPR product on Jan. 2015

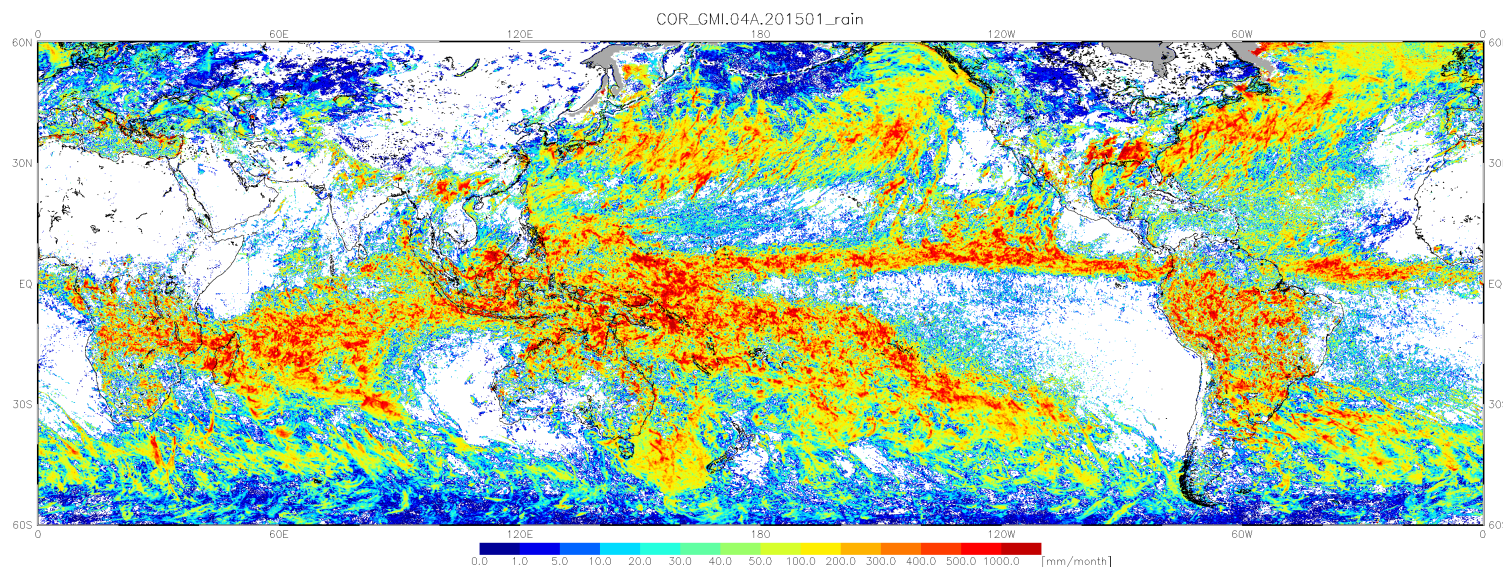
•

*Horizontal pattern of the GSMP\_GMI v7 retrievals were similar to that of the GPM/DPR.*



**GSMP\_GMI v7 (Jan 2015) with a snowfall estimation method by Prof. G. Liu (FSU)**

- There were detections of snowfall in the Western Eurasian Continent and North-West American Continent



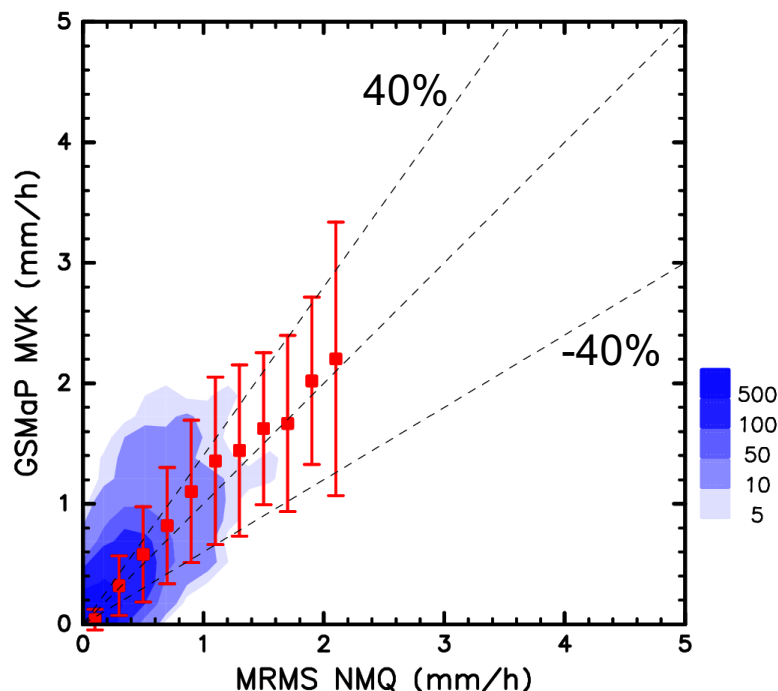


# Validation results of the GSMaP

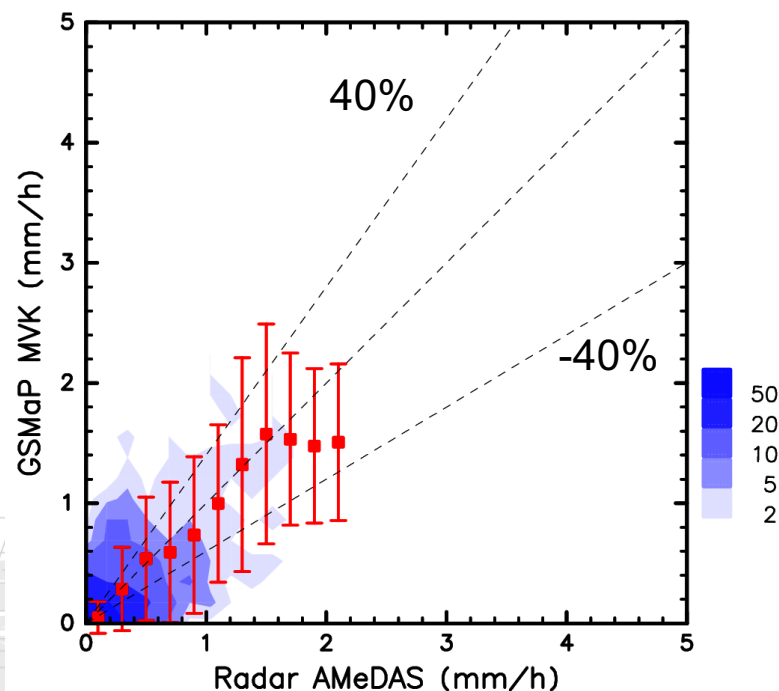


- Validation results of the GSMaP v6 standard product (GSMaP\_MVK, no-gauge-adjustment) are shown using US MRMS and the JMA Radar-AMeDAS (gauge-corrected radar) data during Jun.-Aug. 2015 with 1.5x1.5 lat/lon, daily grids.

US MRMS (provided by NASA GV team)



JMA Radar-AMeDAS



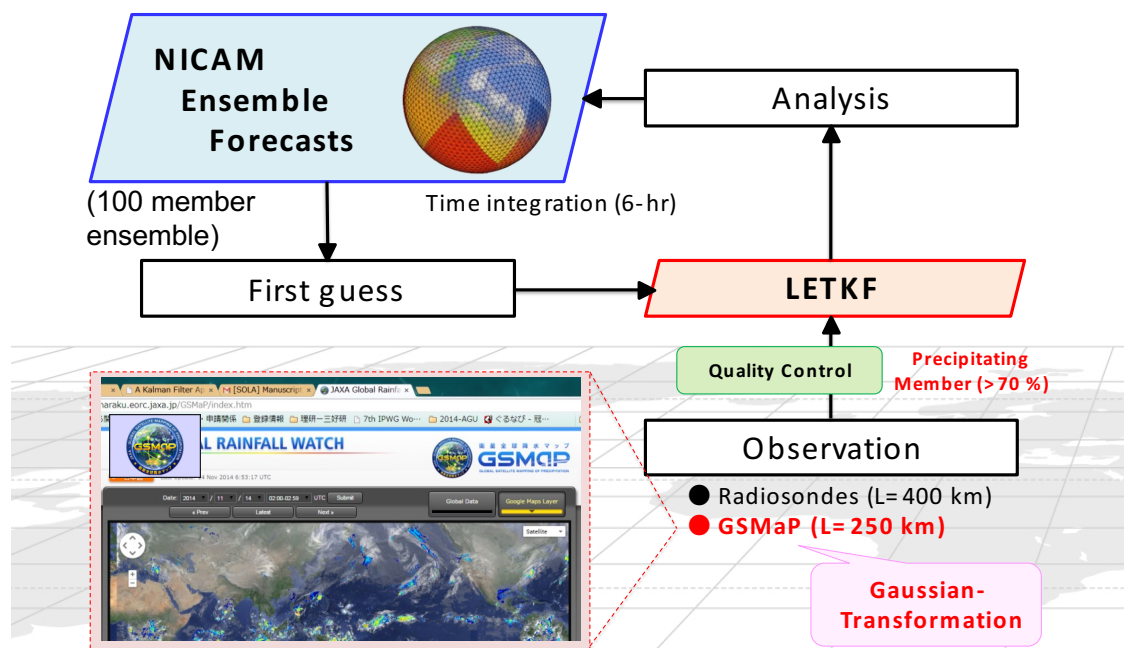
The GSMap\_MVK v6 product well-corresponded to the ground instruments over the Japan and US, except for higher rain rates over the Japan.

# GSMaP assimilation in JAXA supercomputer system

- The NICAM-LETKF data assimilation system using the GSMaP is installed at JAXA supercomputer system generation 2 (JSS2) and experimentally operational in near-real time (see Dr. Kanemaru's poster #130).



## Assimilating GSMaP with NICAM-LETKF



NICAM 100 member precipitation  
2017/07/01 00-24UTC (1 day)



# Summary



- \* The Japanese PMM Science Team started in Apr. 2013 for three-year period.
  - \* 41 proposals for the 8<sup>th</sup> RA (JFY2016-2018)
- \* GPM/DPR instrument is working well.
  - \* The GPM data are available from JAXA G-Portal (<https://www.gportal.jaxa.jp>) and NASA/PPS STORM (<https://storm.pps.eosdis.nasa.gov/storm/>).
- \* GPM products V05 were recently released to the public.
- \* Global rainfall map product (GSMaP)
  - \* GSMaP data (algorithm version V6) are now available since Mar. 2000.
  - \* New V04 (algorithm version V7) was released in Jan. 2017.
- \* Japanese validation activity
  - \* JMA rain gauge/radar network, US MRMS provided by NASA GV team, JAXA Ground Ka-radar experiments and etc.
- \* Japanese application activity
  - \* Utilization of GPM data in the numerical weather prediction (NWP) system, and etc.